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PROTECTING THE FLEET

David Kassing

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PROTECTING THE FLEET

by
David Kassing[1]

The 1970s have seen a continuing debate about the size and structure of the United States Navy's general purpose forces. Some of the issues stem from changes in how the need is perceived. Other issues arise from the sharp increases in costs. But many of the issues arise out of concern about the basic ability of the fleet to perform its functions in the face of ever more capable opposition.

This paper considers some of the problems involved in allocating resources to protection of the fleet. It concentrates on the contribution of surveillance, antisubmarine, antiair, and antisurface ship systems to protection of the Navy's main fleets.[2] The paper begins with a discussion of some of the concepts involved in thinking about protection of the fleet, and then examines some of the major changes in technology and forces that have made protection more difficult. The threats to the fleets are described briefly. The discussion then shifts to the problems of protecting the fleet in two kinds of conflict with the Soviet forces -- tactical nuclear war and non-nuclear war. Finally, there is a brief assessment of the problems of protecting the fleet from attack by third-country forces.

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[1]The author is on the staff of the Center for Naval Analyses. The views expressed in this chapter are his, not those of the Center, the Department of the Navy, or the Department of Defense.

[2]That is, it focuses on issues involved in protecting the U.S. Navy's general purpose forces, not its sea-based strategic missiles, Poseidon and Trident.

Also, although tactical air strikes at enemy ports and bases help protect the general purpose forces, these tactics are not examined in this paper. Nor does it consider the sometimes important contribution of mines and mine countermeasure forces.

BASIC CONSIDERATIONS

To carry out its main wartime functions -- gaining sea control and projecting power ashore -- the fleet must be able to withstand enemy attack. There is a need for protective systems to help the fleet survive. But survival of the fleet is not, of course, the purpose of a naval force. Protection is only one of several capabilities essential to the main wartime mission.

The need to protect naval forces from attack creates a problem for naval planners at every level. Resources devoted to protection compete directly with resources devoted to the main naval functions. The ship designer -- constrained by size or cost -- realizes that self-defense systems, such as armor, detract from striking power. The fleet commander -- constrained by size of available forces -- realizes that deploying his force for better protection may detract from their ability to carry out their main functions. And the naval force planner -- constrained by budgets -- knows that resources directed to defensive systems will not be available for buying offensive capability.

The analyst can prescribe the correct principle for resolution of these problems. Resources should be devoted to protection up to the point where additional investment in protection adds as much to offense as would additional investment in offense. In short, an additional dollar should buy the same amount of added offensive punch for the fleet, whether spent on offense or on protection.[3]

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[3]This can be suggested by a simple example. Suppose, for example, that a defensive system with a life cycle cost of $25 million enables a carrier task group to fly an additional attack sortie a day. Suppose that the attack aircraft for offensive operations have a $50 million life cycle cost and add one sortie a day. Buying one aircraft less costs one sortie, but permits acquisition of two defensive systems, which, in turn, result in two sorties. If the threat is taken as fixed, the incremental returns to defense systems will fall, and this daily sortie capability of aircraft will increase. When the incremental sortie rates are equal -- at, say, 1.6 per day -- the proper balance between offensive and defensive systems has been achieved.

The principle implies that protection will not be perfect as long as resources are limited. Technical questions aside, to provide a perfect defense against even a modest threat would result in a misallocation of limited resources. And, of course, resources are always limited.

Therefore, protection -- and its complement, survivability -- must be considered in probabilistic terms. Navy ships, as the saying goes, are designed to sail "in harm's way"; some will inevitably be harmed. All forces -- whether attacking or defending -- are vulnerable to some degree. Vulnerability per se, therefore, should not be the main issue in the sizing and structuring of naval forces. Rather, the question is this: Allowing for relative vulnerabilities, can naval forces meet a specific need at lower cost than any alternative means -- and, if so, what types of naval forces should be selected?

Though it is easy to state the analytical principle for balancing between protective and offensive capabilities, putting it into practice is quite difficult.

First, there are problems of definition. An individual weapon system can not always be categorized as either offensive or protective. For example, some defensive antiair missiles also have an antiship capability that can be used offensively; an antiship missile, on the other hand, may be used offensively or defensively, depending on the tactical situation. Another example is naval mines, which may be employed for either purpose.

Second, the key questions are obviously quantitative, and the numbers are hard to estimate. Just how much will specific offensive and protective systems add to the fleet's total firepower? The quantitative answers depend on a host of uncertain and uncontrollable factors: the time and place of the conflict, the amount of warning and the level of readiness, the skill and experience of the commanders, the contributions of allied forces, and so on.

Third, the reaction of the enemy to the introduction of new weapons is fundamental to any assessment of their effectiveness; this is very hard to determine. Clearly, the relative ability of the enemy to counter our new systems -- such as Harpoon, Tomahawk, Aegis, Ship Intermediate Range Combat Systems (SIRCS), and lasers -- affects the desired balance among these systems. Since we cannot know the potential enemy's intentions and resource limitations, we can not be sure about his specific reactions, but we can be certain that the measures we take to protect the fleet will draw countermeasures.

These countermeasures can take any form -- from adjusting a simple design to restructuring an entire fleet. Designers of individual systems must consider the characteristics of opposing systems, present and future. In the long run, moreover, the force structure of a navy adapts to counter the capabilities of the opposing force. The present balance between the U.S. and Soviet navies reflects the slow evolution of measure and countermeasure.

The U.S. Navy has long -- and for good reason -- relied on the carrier as the main element of its striking power: for strategic delivery in the 1950s, for conventional tactical air power and antisubmarine warfare in the 1960s and 1970s. Thus the Soviet navy has had a relatively "steady target" for a long period and could design its forces against this relatively fixed threat. The Soviets have now evolved a substantial anticarrier force. Their task has become easier as a result of the reduction in U.S. forces from 24 carriers to 13 in the past 10 years. Viewed in this long-long-term context, U.S. countermeasures to Soviet anti-carrier capabilities are just beginning.

CHANGES SINCE WORLD WAR II

The ability of the fleet to protect itself has come into question largely because of five major changes since World War II. Four are technological developments -- nuclear weapons, nuclear propulsion, anti-ship missiles, and ocean surveillance systems. The fifth has to do with changes in the composition of the U.S. Navy.

1. Nuclear weapons. By the end of World War II, the U.S. Navy had developed reasonably effective defenses against air and submarine attacks. Major combatants built during the war were larger, more heavily armored, and more heavily armed than prewar designs. ASW techniques, employing surveillance, land- and sea-based air, and ASW escorts, were well developed. In the Atlantic, the German submarine force was rapidly being defeated. In the Pacific, the fleet was able to withstand attacks by several thousand kamikazes.

But the 1946 tests at Bikini Atoll demonstrated the awesome effects of nuclear bursts on ships. Ships were sunk or severely damaged by bursts thousands of feet away. Radar and radio antennas were stripped away at even longer ranges. To achieve comparable destruction with conventional weapons would have required one or more direct hits. Clearly, this major increase in the lethality of antiship weapons reduced the need for large numbers of weapons and great accuracy of delivery. Indeed, many, in both East and West, argued that the day of the large surface ship had passed.

2. Nuclear propulsion. By the mid-1950s, both the U.S. and Soviet navies had learned to use nuclear power for submarine propulsion. The submarine thus acquired a tremendous increase in capabilities relative to those of antisubmarine forces. The submarine's main advantage is the stealth that comes from remaining submerged. A diesel submarine must come close to the surface to charge its batteries and can, at best, remain fully submerged for only a few days at a time. But nuclear power permits the submarine to remain submerged for two or three months at a time, making it much harder to detect and counter. In addition, nuclear power

provides higher sustained speeds for reaching station and maneuvering in combat.

Nuclear power in submarines has reversed the situation that obtained at the end of World War II. The antisubmarine forces no longer hold the upper hand. As a result, the seas have become an attractive hiding place for strategic missiles. Moreover, our ability to protect our sea lanes from submarine attack has been sharply reduced.

3. Antiship weapons. Although mines sank or damaged many ships[4], the main antiship weapons of World War II were guns, torpedoes, and bombs. These weapons required the attacker's ships, aircraft, and submarine to come quite close to their targets, where they could then be engaged by defensive forces. Moreover, the chance that a single weapon could hit its target was small, and multiple attacks were generally needed to insure a kill.

The antiship missile met both problems. Cruise missile technology permits the attacker's ships and aircraft to launch their attacks from outside the range of most defensive systems. In addition, cruise missiles have been designed to fly at supersonic speeds and along trajectories that make them hard for the defense to detect and engage. The guidance. and control systems incorporated into antiship missiles permit them to home in on the targets and hit with high reliability.

The consequences for the protection of surface ships are clear: The attacker's weapons can more easily penetrate the fleet's defensive systems, and the effect of each penetrating weapon is increased.

4. Ocean surveillance systems. The ability to hide in the vastness of the oceans has always been one component of the fleet's ability to survive and carry out its missions. During World War II, the main

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[4] Mines accounted for 7 to 8 percent of sinkings of naval forces and about one out of eight of the more than 12,500 merchant ships sunk.

surveillance systems were high-frequency direction-finding networks, which detected enemy radio transmissions, and aircraft, which searched visually and electronically. These systems added somewhat to our knowledge of the enemy's operations and our ability to find and attack his forces, but often intelligence -- code-breaking, in particular -- added a great deal more. By and large, U.S. ships were free to range the oceans safely, if they took routine safety precautions -- zigzagging, running dark, etc.

Today, such measures are not enough to insure ships at sea against being located. The technologies of World War II have been retained and improved. New technologies have been added. Long-range radars, mounted on satellites, can detect ships. Electronic signal monitoring equipment, out in space, can detect emissions from ships. There are infrared detectors and acoustic arrays.

As a consequence, large surface ships can be located with some precision almost anywhere on the oceans. There remain, however, difficulties in identification and tracking under some circumstances.

These technologies illustrate the difficulty in classifying naval capabilities as either offensive or defensive. Though these advances in technology make protection of the fleet more difficult, they can also help protect it, as will shortly be shown.

5. Changes in the U.S. Navy. In addition to technical developments, changes in the size and composition of the U.S. Navy have added to the difficulties of protecting the fleet. Over the past 30 years, the main striking power of the United States Navy has been concentrated in fewer and fewer units. In the 1950s, the last battleship was retired,[5] and in the 1960s, a decline in carrier force levels began. This year, the Navy will operate 13 carriers and deploy four carrier task groups overseas.

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[5]The battleship New Jersey was returned to service for action off Vietnam and was again decommissioned in 1969.

Part of the reason for this concentration is economic: Large ships generally provide more offensive capability per dollar invested, particularly if they are not opposed, as has been the case with U.S. carriers since 1945. Part of the reason is fiscal: Older, smaller carriers were retired in the early 1970s, when DoD budgets were particularly tight. And part of the reason is the technical change just discussed. These changes have induced the Navy to invest more in costly, sophisticated defense technologies; as a consequence, fewer units can be procured and operated.

Whatever the reasons, the consequences of this concentration are clear: It is easier for an enemy to concentrate against the fleet, easier to achieve tactical surprise, and easier to knock out a substantial fraction of the forces.

THREATS TO THE U.S. FLEET

The need to protect the fleet so that it can survive and carry out its main functions does not derive from technological developments *per se*. The fact is that all of these technologies have been incorporated in the forces of our main potential opponent -- the Soviet Union -- and some have been incorporated in the navies of other potentially hostile nations. In the future, more and more navies will be acquiring the technologies that are now called "modern."

Soviet Navy

It is not necessary to detail here the growth in the Soviet naval forces and its capabilities. These have been described and examined by many observers.[6] Suffice it to say that the Soviet navy has enough forces, widely deployed, to pose a real threat to the U.S. fleet in the event of war.

The Soviets cannot, however, allocate all of their naval forces to attacks on U.S. surface forces. Though defense against carrier task groups has a high priority in their navy, the priority of strategic missions is even higher. Some portion of the Soviets' submarine and antisubmarine forces would probably be assigned to protection of their strategic missile-launching submarines -- in enclaves or redoubts -- and others would be directed against U.S. strategic missile submarines.

The main Soviet forces for attack on the U.S. surface fleet are cruise missile submarines and antiship bombers. Beyond question, the cruise missile submarines are designed and deployed against U.S. carrier forces. Today, the Soviets have 60 of these submarines, 44 nuclear-powered and 16 diesel-powered. Considering the requirements for overhaul and maintenance and the long distances they must sail to reach U.S. carrier operating areas, the numbers that can be deployed continuously are much smaller. In time of crisis or rising tension, the Soviets might be able to get as many as 40 submarines into position to attack U.S. forces.

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[6] For example, Arnold Moore discusses the changes in the Soviet navy since the mid-1960s in a chapter on "General Purpose Forces: Navy and Marine Corps" in Arms, Men, and Military Budgets: Issues for Fiscal Year 1977, edited by W. Schneider, Jr., and F.P. Hoeber (New York: Crane, Russak & Co., 1976), pages 57-69. An earlier but more comprehensive analysis of the evolution of Soviet naval forces was done by Barry M. Blechman, The Changing Soviet Navy (Washington: The Brookings Institution, 1973). For a detailed description of Soviet naval forces and their characteristics, see Capt. John E. Moore, The Soviet Navy Today (New York: Stein and Day, 1975).
Michael MccGwire has organized several conferences on the Soviet navy. Papers from these conferences have been published as Michael MccGwire (ed.), Soviet Naval Developments, Capability and Context (New York: Praeger Publishers, 1973); Michael MccGwire, Ken Booth, John McDonnell (eds.), Soviet Naval Policy Objectives and Constraints (New York: Praeger Publishers, 1975); Michael MccGwire, John McDonnell (eds.), Soviet Naval Influence: Domestic and Foreign Dimensions (New York: Praeger Publishers, 1977).

The Soviet navy also has a force of more than 300 bombers that are obviously designed and armed for antiship warfare. As many as 80 to 90 percent of them could be brought to bear against U.S. carrier forces. In addition, the Soviets might assign some of their Long Range Aircraft (LRA) to naval tasks.

Some Soviet surface ships are equipped with long-range (250-nm) antiship missile systems: the Kiev class carriers, 4 Kresta I cruisers, and 4 Kynda cruisers. The Soviets are also equipping Kashin and Kildin class destroyers with a modernized version of the SSN-2, a 30-mile missile. This program may eventually extend to all 23 ships of the Kashin and Kildin classes. Finally, the Soviets have 17 Nanuchka class (850-ton) corvettes each armed with six 150-nm SSN-9 antiship missiles.[7] Some of these ships have occasionally deployed to the Mediterranean.

To help these forces find their targets, the Soviets have significant capability for surveillance of the ocean's surface. They have been scanning the ocean's surface with radar satellites since 1967. During Okean-75,[8] two radar satellites reported on a simulated convoy in the Bay of Biscay. According to Aerospace Daily (2 June 1976), "The radar spacecraft are able to sweep large areas with a signal strong enough to provide data that can be analyzed by commanders on land or sea." A radar satellite could detect large surface ships but might have difficulty in distinguishing warships from large, fast merchant ships.

The Soviets deployed a second type of ocean surveillance satellite in December 1974. Satellites of this type do not use radar and are therefore assumed to be electronic listening or television devices. Either type of sensor could help identify ships. An electronic listening satellite, of course, requires a "cooperative target," one that is operating its radars or radios.

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[7] CAPT John E. Moore, editor, Jane's Fighting Ships 1977-78 (New York: Franklin Watts, 1977), p. 706.

[8] From "Soviets Seen Operating Two Types of Ocean Surveillance Satellite," Aerospace Daily," 2 June 1976.

Once the U.S. forces had been located, the Soviets could attack them with torpedoes and antiship missiles.[9] Of Soviet torpedoes, little can be said here. There are at least two types, and they may be armed with conventional or nuclear weapons.[10] But their range, speed, and guidance mechanisms are kept secret.

More can be said about Soviet antiship missiles. For a long time, the Soviets have led the world in the development and deployment of antiship missiles. At least ten different antiship missiles are now deployed in their fleet. Four can be launched from ships on the surface (including surfaced submarines), one can be launched at ships from submerged submarines, and five can be launched at surface targets from aircraft. The main characteristics of these missiles are listed in table 1.

TABLE 1

SOVIET NAVAL MISSILES FOR ATTACKING SURFACE SHIPS

	Range (nm)	Speed (mach)	Warhead type	Initially operational
Surface-launched				
SSN-2 (Styx)	23	0.9	HE	1960
SSN-3 (Shaddock)	150-250	1.5	HE or nuclear	1961-62
SSN-9	150	1.0+	HE or nuclear	1968-69
SSN-12	250?	?	?	
Submerged-launched				
SSN-7	30	1.5	?	1969-70
Air-launched				
AS-2 (Kipper)	115	1.0+	?	1960
AS-3 (Kangaroo)	400	1.5+	?	1961
AS-4 (Kitchen)	185?	2.0+	?	1965
AS-5 (Kelt)	120	0.9	?	1968
AS-6	150	3.0	?	1970-71

Source: Capt. John E. Moore, editor, Jane's Fighting Ships 1977-78 (New York: Franklin Watts, Inc., 1977), pp. 781-782.

HE = high explosive
NATO code names are given in parentheses.

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[9] The Soviets also have a substantial inventory of antiship mines, but most would probably be employed defensively in waters close to the Soviet Union.

[10] Kosta Tsipis, Tactical and Strategic Antisubmarine Warfare, (Cambridge, The MIT Press, 1974), p. 93.

The table shows a variety of stand-off ranges, missile speeds, and warhead types. The missiles employ radar, and infrared homing mechanisms in the terminal stages of attack. About half the Soviet navy's antiship missile launchers are aboard submarines, 40 percent more are on aircraft, and the remainder are on surface ships.

The Soviets' naval writings and exercises tell us something about their plans for employing these weapons. Admiral Gorshkov has set down his views quite clearly. He expects future combat to be quick and decisive:

> "... the combat activity of the navy in the future will be a complex combination of simultaneous and successive combat operations, swift and brief, ending with the attainment of decisive goals ..."
>
> "In many cases the grouping of enemy naval forces will have to be destroyed within a very short, specified time, before they can fully employ their own weapons."[11]

This suggests concentration of air, surface, and submarine forces against the opposing fleet, and the employment of surprise, coordinated attacks. This interpretation of the Soviets' approach is confirmed by a review of their major exercises. In both 1970 and 1975, major Soviet naval exercises showed that they could conduct coordinated antiship attacks in ocean areas near the Soviet Union where the U.S. fleet might well be deployed. In 1975, special emphasis was apparently placed on attacks on surface ships, mainly by aircraft equipped with antiship missiles. In this exercise, the Soviet navy demonstrated that its surveillance, command and control, and attack systems could organize and conduct attacks on an opposing fleet.[12]

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[11] Sergei G. Gorshkov, Morskaya moshch' gosudarstva (Military Publishing House: Moscow, 1976), pp. 370-71. I am indebted to James M. McConnell for the translation.

[12] For a more complete description of the 1975 major Soviet naval exercise, see B.W. Watson and M.A. Walton, "Okean-75," U.S. Naval Institute Proceedings, Vol. 102/7/881 (July 1976), pp. 93-97.

Other Navies

Much of the new naval technology, both U.S. and Soviet, has already appeared in other navies; more is likely to find its way there in the next 10 or 20 years. How far this trend goes depends on the costs of the systems and the budgets available for naval procurement.

Satellite surveillance systems are probably beyond the means of all but the superpowers, and the costs of nuclear submarines will preclude development and acquisition by all but a few states. This is also true of most modern ASW systems.

But there are now a variety of naval missile systems, as well as small-ship sonars, radars, and combat information systems, on the market. Some of this technology is in the hands of smaller navies -- for example, the Gabriel, the Seacat, the Otomat, the SS-12 -- and more will undoubtedly be acquired. Table 2 lists the main missile systems now available for antiship warfare. Note that most of these are relatively short-range weapons.

TABLE 2

SELECTED ANTISHIP MISSILES

Type	Developer		Range (nm)	Speed (mach)
Surface-to-surface	France	Exocet	20	1.0+
	France	SS.11	1.6	?
	France	SS.12	4.4	Subsonic
	Intl	Otomat	32	0.9
	Israeli	Gabriel	14	0.7
	Italy	Seakiller I	6	1.9
	Italy	Seakiller II	13	1.9
	Italy	Seakiller III	24	1.9
	Norway	Penguin	14.5	0.7
	Sweden	Rb08A	100?	0.85
	UK	Sea Dart	40	?
Air-to-surface	France	Martel	30	?
	France	AS 20	4	?
	France	AS 30	6	1.5
	Italy	Airtos	6	1.5
	UK	Sea Skua	5?	?

Sources: Jane's Fighting Ships 1977-78, pp. 780-81, and General Dynamics Corporation, The World's Missile Systems, 3rd edition, November 1976.

The diffusion of this technology is well underway. Antiship missiles are now employed by the navies of such diverse states as India, Malaysia, Senegal, South Africa, and Venezuela, as well as China, Cuba, North Korea, and Vietnam. In the future, therefore, even small nations may pose some threat to at least the surface forces of other nations.

These developments in the Soviet and other navies have been underway for many years and are well understood. They have given rise to considerable concern about the utility of large surface warships in future combat. When asked to give his assessment of attrition of U.S. forces in conflict in the mid-1970s, Admiral Holloway stated his views very clearly:

> "I think I can answer it in one brief paragraph. In a conflict with the Soviets, I would expect very heavy losses to our carrier forces if nuclear weapons were used. If nuclear weapons were not used, I would predict about a 30 to 40 percent attrition of our carriers. We have no figures, statistically, because we have no view into the future with the infinite set of scenarios in which we could go to war. That is my judgment.
>
> If we go to war with a client of the Soviet Union, as we have historically since World War II, I think that carrier attrition would measure less than 10 percent."[13]

PROTECTING THE FLEET IN TACTICAL NUCLEAR WARFARE

The task of protecting the fleet is most difficult if nuclear weapons are used to attack it. Tactical nuclear warfare is often equated to combat with low-yield nuclear weapons. In naval warfare, however, this is not necessarily true. Designers of naval nuclear weapons have not been constrained by any need to limit collateral damage or to permit early entry of their own troops.

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13 Testimony of Admiral James L. Holloway, Chief of Naval Operations, U.S. Congress, Senate, Committee on Armed Services, Hearings on Fiscal Year 1976 Authorization, Part 2, February 11, 1975, p. 742.

Instead, designers of nuclear systems for naval use have incentives that could lead them to larger warheads. High yields can compensate for some of the common limitations of naval warfare, such as the difficulty of differentiating the primary target from other enemy ships in the vicinity. They make the utility of "dead man" fuzing higher, and this reduces the effectiveness of shipbased protective systems. High yields offset the difficulties of locating a target precisely, and they reduce the need for terminal homing mechanisms that are vulnerable to decoying or jamming. Finally, they economize on scarce shipboard magazine space: Higher yields make for surer kills, and fewer weapons are needed per target.

From the viewpoint of protection, the defenses against nuclear weapons must be highly effective. Penetration of the protective screen by one or two weapons can spell disaster or, as Admiral Holloway put it, "very heavy losses."

Nevertheless, the debate over the size and structure of the U.S. fleet has barely touched on tactical nuclear war. Most broad assessments of naval capabilities -- posture statements, net assessments, campaign analyses, general reviews -- focus almost entirely on war with conventional weapons. This does not mean there has been no work on naval warfare with nuclear weapons. Of course, there have been many point papers and memoranda, design studies, analyses of individual weapons systems, and even an occasional CNO statement of policy. But the basic rationale for the Navy's tactical nuclear posture has, in fact, received little attention. The literature on naval warfare with nuclear weapons is negligible. Even the critics of the U.S. Navy seem to have ignored the issue.

There are several reasonable explanations for the omission. One is the great, steady emphasis that has been placed on planning forces for only the conventional defense of Europe. A second explanation is that the U.S. and Soviet navies are apparently the only ones with major tactical, independent nuclear programs. A third explanation is the most likely of all: During the 1960s, when studies were made of tactical nuclear warfare at sea, the results were both clear and distasteful. According to one assessment that was made at the time:

> "It is apparent from official comment ... that ... a preponderance of opinion is emerging that, even on purely tactical considerations, the resort to nuclear weapons would not favor the West with its large investment in both military and civilian surface fleets."[14]

The recent assessment by Adm. Holloway also points out that tactical nuclear weapons would make a substantial difference in the survivability of surface ships. But just such considerations could well have led the Soviets to emphasize the use of nuclear weapons against surface ships.

As we have seen, the Soviets do seem to be planning for the kind of short, sharp naval combat that is consistent with tactical nuclear weaponry. And their ships are faster but have less endurance; they have more immediate firepower,but many lack reloads for their missile launchers. Moreover, Gorshkov's writings do not distinguish between nuclear and conventional weapons.

There has been, then, a difference between the U.S. and Soviet navies in their basic attitude toward use of nuclear weapons at sea. This difference has followed from the differences in missions. Nuclear weapons are highly effective against both surface ships and submarines -- in fact, all kinds of targets. For a long time, the Soviet navy had the mission of defending Soviet territory from carrier-launched strikes. A carrier is

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[14] L.W. Martin, The Sea in Modern Strategy (New York: F.A. Praeger, Inc., 1967), p. 89.

large and easy to find, but hard to sink with conventional weapons unless it is hit many times. A single nuclear weapon, however, can put it out of action.

The Western navies have felt most threatened by the Soviet submarine force. The hardest task for an antisubmarine force is detecting and localizing the submarine, not attacking it once found. Once a submarine has been localized, nuclear weapons can destroy it most effectively, but the kill radii are not large enough to compensate for normal uncertainties about the position of the submarine.

The general assessment, therefore, has been that nuclear weapons would be of little help to the antisubmarine forces of the Western alliance, but would greatly reduce the survival ability of carrier forces, amphibious assault groups, and convoys. One consequence is that thinking about tactical nuclear war at sea has been minimal in the West.

The U.S. Navy has retained nuclear weapons for several systems (table 3). The presence of nuclear weapons aboard U.S. ships may have a deterrent effect on Soviet use of nuclear weapons against them, as does the prospect that tactical nuclear war could quickly escalate to general nuclear war. Carrier forces or military convoys represent sizable military capabilities; destruction of them with nuclear weapons might easily evoke a nuclear response at a higher level. On the other hand, the Soviets may reason, as others do, that if use of nuclear weapons is limited to the oceans, escalation is much less likely because damage is limited to the military forces.[15]

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[15] See Edward Wegener, The Soviet Naval Offensive, trans. H. Wegner (Annapolis: U.S. Naval Institute, 1975), p. 11, for an example of this argument.

TABLE 3

PRESENT AND POTENTIAL TACTICAL NUCLEAR WEAPONS
OF THE U.S. NAVY

	Present	Under Study
Antisubmarine	SUBROC ASROC Mk 45 torpedo B-57 bomb	Mk 46 torpedo
Antiair	Talos Terrier	Standard missile
Antiship		Harpoon Tomahawk

Source: F.P. Hoeber and W. Schneider, Jr. (eds.), Arms, Men, and Military Budgets: Issues for Fiscal Year 1978 (New York: Crane, Russak, 1977), p. 127.

A great many factors that weigh in the tactical nuclear balance have changed since the 1960s. But, regardless of changing conditions, the basic vulnerability of surface ships to nuclear weapons remains unmistakable. Dispersed carrier formations and convoys only increase the number of weapons needed to kill a given number of ships; they do not reduce the inherent vulnerability of ships to the nuclear blasts. Since the enemy has nuclear weapons and may be a net gainer from using them, U.S. forces must be designed for nuclear -- as well as conventional -- combat.

To do so may require major redesign of U.S. forces. Investing more in submarines and proliferating the numbers of small but potent surface ships are possible responses. High-speed surface effect or hydrofoil craft can be employed to enhance the survival ability of surface warships.

But such options do little to enhance the ability of carriers and convoys to survive nuclear attack. The cost of building a high-speed carrier of any size would be colossal, and merchant cargoes are likely to continue being transported in economical, relatively slow, surface ships. The vexing problem of defending these high-value surface units against nuclear attack, therefore, will probably continue.

To defend such forces will require great improvements in protection, protection best achieved through destruction of the enemy's weapons before they can be launched. The prospect of tactical nuclear war should therefore shift emphasis even more toward destroying enemy aircraft and ships; here, land-based aircraft can make an important contribution. Better surveillance is needed, to alert the defending forces in time to intercept the attackers before they can reach launch position.

Protection against nuclear-armed antiship missiles also requires air defense missile systems of longer range. Such systems -- designed to hit missiles with missiles -- are likely to be complex and costly. Last-ditch point-defense missile systems are of only limited value; the ranges are too short.[16]

Before the Navy decides on major changes in its force structure to reflect the possibility of sea war with nuclear weapons, it is important to examine the change that has taken place since the 1960s. Beyond the improvements in surveillance and the deployment of antiship missiles that have already been discussed, these evolutions include:

-- Changes in U.S. and Soviet forces,
-- Improvements in acoustic detection,
-- Changes in antisubmarine strategy and tactics, and
-- New technology for tactical nuclear weapons.

It is hard to gauge the net effect of all these changes. But it is apparent that there is no simple solution to the problem of protecting surface ships from nuclear attack. War at sea with nuclear weapons would probably result in a quick double knock-out of many Soviet and U.S. surface ships. The use of nuclear weapons would also accelerate the pace of antisubmarine warfare, the advantage going to the side with the best

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[16] The U.S. Navy is doing research on faster ships, better protective systems, and so on. The most important of these programs are discussed in the next section of this paper.

detection and localization systems. Here, the U.S. submarine force would likely prevail.

So long as U.S. forces are planned for conventional conflict, the ability to protect the fleet in nuclear war will derive mainly from developments for non-nuclear war. This is the subject of the next section.

PROTECTING THE FLEET IN A NON-NUCLEAR WAR

U.S. Naval forces -- like other general purpose forces -- have been sized and evaluated for worldwide non-nuclear war with the Soviet Union. In such a conflict, the fleet would be most likely to engage Soviet forces in the Mediterranean, in the North Atlantic close to Europe, and in the Western Pacific. Under some circumstances, the U.S. and Soviet fleets might fight in the Indian Ocean as well. In any of these areas, the U.S. forces involved could include aircraft carriers, amphibious forces, and logistic support groups. The Chief of Naval Operations has made this assessment of the threat these forces will face:

> "We rate the Soviet maritime threat in this order. The most severe threat is their submarine force, the second most severe threat is the air force, and the third in ranking is their surface navy.
>
> The reasons for this are complex. They have a great many submarines and their submarines are hard to detect. On the other hand, they have a great many aircraft with air-to-surface missile systems, and the important thing about their air forces is that they can shift them rapidly from one theater to another and deploy them quickly against our forces. Their surface navy is formidable, that is true, but it is substantially less of a threat than the first two, because it takes longer to deploy, and can be kept under continuous surveillance."[17]

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[17]Testimony of Admiral James L. Holloway, U.S. Congress, House of Representatives, Subcommittee on the Department of Defense, Hearings on the Department of Defense Appropriation for 1978, 74th Congress, 1st Session, Part 2, p. 523.

To attack a fleet, an enemy must take several steps. First, he must find out where it is and acquire enough information to predict its general movements. He must also find out enough to distinguish his main targets from other ships in the vicinity. Then he must prepare his forces for attack, arming them with the proper weapons and countermeasures. His forces must then get into position to launch their attack; to do this, they may have to overcome several layers of defense. To coordinate an attack with several kinds of forces, moreover, requires extensive communication. The weapon must withstand additional defenses, select its intended target, and hit it with enough strength to put it out of action.

Accomplishment of these tasks depends on having detailed information about U.S. and allied forces, their system designs, their tactics and countermeasures -- information acquired in peacetime through intelligence and surveillance.

The likelihood of success in such an attack depends on a variety of circumstances. Planning a preemptive or surprise attack in peacetime is the least difficult of all.[18] Information about the positions and movements of the U.S. fleet can be supplied continuously by ships acting as "tattletales." Preparation for the attack can be leisurely and the attack timed carefully. Since shooting has not started, the attacking forces can move into position without opposition. Finally, if they achieve surprise, the defenders are likely to be less ready. Such an attack by the Soviets might focus on four or five U.S. task forces.

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[18] Planning and conducting an attack in a peacetime exercise against one's own forces is, of course, even easier. Safety and resource constraints remove some of the problems that would complicate plans for a real attack. Because of these artificialities, one can discount somewhat the performance achieved in such major fleet exercises as Okean-75.

But, even a few days into a major war, circumstances are different, and mounting an attack on a U.S. carrier group is much harder. The attacker has less information -- and poorer information -- to go on, and his attacking forces face stronger, readier defenses.

Some of the protective measures that the fleet can take are implied by the attacker's problems. As with the attacks, effective protection requires a great deal of information about the enemy's forces, his weapon systems and operations, his state of readiness, and his tactics. Protective measures can be characterized in several ways, depending on when they take place, where they take place, what they protect, and how they protect.

Some of the most important protective measures must be taken in peacetime. Gathering intelligence about the enemy is crucial. But proper training and readiness are also vital to effective protection. How the fleet is operated in peacetime can help complicate the enemy's problem in formulating his attack strategy. If the defenders' deployments are varied, the enemy finds it harder to prepare his attack. Finally, the way the fleet is structured can either help or hinder the defense. As noted earlier, concentrating the fleet's main striking power in fewer and fewer units aggravates the problems of the defenders. But if the defenders disperse their striking power more widely -- through reliance on larger numbers of smaller ships and proliferation of long-range cruise missiles on many ships -- they can acquire a measure of protection that is not otherwise possible.

Other protective measures, such as jamming the enemy's communications, destroying his surveillance systems, and attacking his forces, are available in wartime.

Another way to characterize protective measures is by their location:

Forward protection -- including forward surveillance and intercept systems -- is far from the defender's naval forces.

Area defenses protect all the ships in the vicinity.

Local defenses protect the area immediately around that fleet.

Point defense protects only the ships they are mounted on.

Protective systems can also be defined by the way they operate to nullify the enemy's attack. "Hard-kill" systems destroy his ships, aircraft, or weapons. "Soft-kill" systems neutralize the effects of the weapons by diverting them from their targets.

Just as Soviet forces may combine multiple elements to attack the fleet, the U.S. Navy employs multiple units to protect it. The kinds of protective measures just discussed are combined in a great variety of combinations, a concept often called "defense in depth." Individual components of the defenses are designed to take advantage of various weaknesses in the opponent's position, weapons, or tactics. Generally, a defense in depth is well hedged -- an enemy breakthrough in one technology or tactic will not defeat the entire defense. Rather, the defense will degrade gradually as specific elements in it are neutralized or destroyed.

The remainder of this section discusses protection of U.S. Naval forces against submarine attack and air attack by Soviet forces. In each case, we will state the problem briefly, discuss the near-future (1980s) prospects for protecting the fleet -- based on the U.S. Navy's development and procurement programs -- and then look at more distant possibilities (1990s) on the basis of present trends in research.

Antisubmarine Warfare (ASW) Protection

The CNO places the Soviet submarine threat at the top of his list because the Soviets have many submarines and they are hard to find.

Locating the enemy submarines and sinking them before they can get into position to attack is the classic ASW problem. In World Wars I and II, the submarine's presence was often not revealed until it had made its attack. A torpedo hit on a ship then served as a "flaming datum," attesting to the presence of at least one submarine. Modern, nuclear-powered submarines are even harder to detect than the conventional, diesel-powered submarines of earlier times.

The addition of antiship missiles to the submarines' armament adds a further complication. These weapons travel much farther than torpedoes. Against the submarines that fire these cruise missiles, ASW forces must therefore provide protection at much greater ranges.

The best known technique for detecting a submarine is to listen for the noises generated by its machinery and hull. But the transmission of sound through the water varies greatly with acoustic frequency and such water conditions as temperature and salinity. Detection of submarines must therefore be viewed in probabilistic terms. Indeed, no single ASW action to detect or attack a submarine has a high probability of success. Consequently, ASW is a matter of probabilities, relying on the cumulative effect of several different kinds of measures to defeat the submarine. The Navy has procurement and development programs underway into a variety of measures to enhance ASW capabilities in the 1980s.

ASW in the 1980s. The best guess about antisubmarine technology in the 1980s is that it will move along currently recognized paths. For many years, some research managers held out hope for a breakthrough in ASW that would make it easy to see through the water and find submarines. So far, no such breakthrough has appeared. Rather, improvement in ASW has resulted from a steady accretion of small advances in sensors and weapons. Much of the improvement stems from the application of modern computers and sophisticated methods to the processing of acoustic information. Still, the detection of submarines is likely to be the central ASW problem of the 1980s. Success in ASW will depend on coordinated action by diverse forces, organized to create ASW defense in depth.

The U.S. Navy monitors submarine activity in areas where enemy submarines might go to make their attacks. Information about any submarines detected can be passed to force commanders for use in directing their antisubmarine searches. The information provided by surveillance makes the search force far more effective than it would be if it had to depend entirely on random search of broad ocean areas. A force commander can also use this type of surveillance information to protect his forces by directing them away from suspected concentrations of enemy submarines.

The Navy's surveillance systems are now being improved for the 1980s in several respects. Processing and communications techniques are being sharpened to increase the numbers of detections and extract more useful information from those detections.

A mobile surveillance sensor system is being developed to provide fleet commands with a deployable capability in the 1980s. It will augment other surveillance coverage and will enhance surveillance in important areas -- for example, where a carrier is operating.

Because most Soviet submarines must sail through relatively narrow choke points before getting into position to attack the U.S. fleet, a strategy of setting up protective barriers in these areas offers sizable advantages. The main elements of the Soviets' submarine force are in their Northern and Pacific Fleets. Submarines based in northwestern Russia must sail through the Barents Sea and the gap between Iceland and either the United Kingdom or Greenland to reach the Atlantic. In the Pacific, some Soviet submarines are based in the Sea of Japan and must pass through one or another of the narrow passages between it and the open ocean. ASW forces in these passages can intercept these submarines before they can get into position to attack the fleet.

Which types of forces to employ depends on the distance of the barrier from the Soviets' defensive forces. Close to the Soviet Union, submarines are most suitable, being better able to survive. In more distant areas, remote from Soviet defenses, the barrier operations can be conducted by aircraft and surface ships. ASW mines can also contribute substantially to the effectiveness of barriers.

The U.S. Navy is improving every component of its ASW force for the 1980s. As many as 40 nuclear attack submarines of a new class -- the SSN-688s -- will enter service in the 1980s. They should be even more effective than earlier generations of U.S. Navy attack submarines in barrier operations because their improved sensors will extend their detection range.

The Navy's land-based patrol aircraft -- the P-3s -- are being updated though the next generation of ASW patrol aircraft will probably not appear in significant numbers until late in the 1980s. New sonobuoys and processors will improve the ability of the P-3Cs to detect, identify, and attack submarines.

In the 1980s, many ASW surface ships will be equipped with tactical towed array sonars. These will lengthen the range at which surface ships can detect a submarine, making them far more effective in a barrier role. To prosecute submarine contacts, ASW surface forces will employ the LAMPS helicopter. With sonobuoys, radar, electronic warfare equipment, magnetic anomaly detectors, and torpedoes, LAMPS will find and attack enemy submarines. Use of these helicopters extends greatly the range of ASW operations by surface ships.

Finally, the Captor ASW mine, long under development, should enter service in the 1980s. It will be particularly effective in antisubmarine barriers.

Most of the systems will then be able to operate in ASW barriers and help provide U.S. carrier and amphibious forces with local protection. Land-based patrol aircraft, nuclear attack submarines, and ASW surface ships will all help to screen task groups from enemy submarines. The improvements represented by SSN-688s, improved P-3Cs, and the tactical towed array/LAMPs team will add to the fleet's ability to protect itself against submarines that penetrate outer layers of protection. In particular, the employment of nuclear submarines in support of carrier operations represents a fairly recent application of a highly effective ASW tactic. As we move into the 1980s, the fleet's tactics for operating SSNs in carrier groups should become significantly more effective.

The carriers themselves, of course, contribute to ASW capabilities. The S-3A, a modern carrier-based ASW aircraft, will be in the fleet throughout the 1980s. In addition, the carrier force itself may begin to change during the 1980s. If new, smaller carriers are acquired, the fleet's capacity for ASW in distant areas will be increased. Perhaps an even smaller VSTOL carrier or VSS (VSTOL Support Ship) will be built by the end of the 1980s. In the 1980s, such a ship will rely largely on such helicopters as LAMPS for its ASW capability.

Unless the Soviets unveil a surprise in the form of a wholly new and greatly improved submarine force, the steady relative improvement in the U.S. Navy's ASW capabilities, observed in the 1970s, should continue in the 1980s.

ASW in the 1990s. Projections of ASW posture and capability to the end of the century are necessarily speculative. The best approach is to identify the research activities and concepts that may lead to successful applications, rather than predict the approaches that will be preferred when technical limitations, operational performance, and costs are better understood.

The types of improvements in acoustic ASW techniques sought in the 1970s will undoubtedly continue to be goals of research. For example, the Defense Advanced Research Projects Agency (DARPA) has a program in the technology of large acoustic arrays, studying hydrophone technology, telemetry of acoustic data, and deployment techniques for large arrays. Another DARPA ASW program is studying the oceans to determine the limits of performance by acoustic arrays.[19] Improvements in the power of computers for ASW will surely continue. Faster computing is important in ASW information processing, and computing is one field in which the United States holds a substantial technological lead over the Soviet Union.

[19] Statement by the Director, Defense Advanced Research Projects Agency, Fiscal Year 1978 Program for Research and Development, February 1977, p. I-12.

Scientists have also been investigating a variety of non-acoustic techniques. Though more than one technology -- in ASW, as elsewhere -- has failed to fulfill its early promise, it would be unwise to write off non-acoustic techniques. Advanced research programs are looking at all the ways in which submarines disturb the natural environment, searching for alternative means of detecting submarines. The main signatures being studied are electro-magnetic, hydrodynamic, and material.[20]

High-speed ASW surface ships also offer advantages for some ASW applications. Hydrofoils, surface effect ships, and wing-in-ground-effect (WIG) vehicles are much faster than conventional surface ships with displacement hulls. Though high speed is not essential to some ASW tasks -- such as convoy escort -- it permits a sprint-and-drift tactic that may yield higher search rates than is available to destroyers and frigates. Moreover, there are situations in which a force of modest size, prosecuting a moderately distant contact, may have to respond quickly. A high-speed surface ship with a small complement of helicopters would be highly useful in such circumstances.

Submarines will continue to be effective ASW vehicles in the 1990s. Some research, now underway, may open the way to the development of small, militarily effective submarines. If research into low-drag technology is successful, deployment of a force of small submarines would become possible.[21] These submarines could both strengthen barriers and enable the barriers to degrade more gradually under attack.

The Navy Department is also studying the use of large, land-based aircraft for ASW. Large aircraft offer several possible improvements in ASW. One is that they can carry more sensors or larger sensors

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[20] Ibid., p. II-30.

[21] Ibid., p. II-18.

and thus cover more ocean area. In addition, they could stay longer on station. Another advantage is the possibility of carrying more on-board processing equipment, to improve the chances of detection. A third advantage is the capacity for more ASW weapons, enhancing the chances of hitting any submarine taken under attack. Larger aircraft could also have higher speeds, valuable in prosecuting distant contacts.

Finally, there is VSTOL aviation, which may well find an application in ASW in the 1990s. The Navy has embarked on an ambitious VSTOL program, one of whose early objectives is to develop an ASW VSTOL aircraft. Such aircraft, operating on many small VSTOL carriers or air-capable ships, could sweep large areas free of submarines and make those waters safer for convoys or carriers.

Antiair Warfare

The Chief of Naval Operations described Soviet aircraft as the second most serious threat to the fleet because of their numbers and speed. If Soviet aircraft were to launch concentrated attacks on individual carrier groups, they could saturate the defenses -- though saturation attacks could not, of course, be mounted against all U.S. carriers at the same time. To prevent saturation attacks, the Navy must be able to exact so heavy a price from the enemy that such attacks will appear unprofitable.

As in the case of ASW, protection of the fleet from air attack relies on a defense in depth. Because events in air warfare move so swiftly, however, defense must succeed the first time; the probability of detection, intercept, and kill must therefore be high. It is true that large warships are armored and compartmented so that they can take some hits from non-nuclear weapons, but each hit increases the chance that the ship or its weapons will be put out of action.

In addition to defense against aircraft, the fleet must be defended against antiship missiles launched from submarines and surface ships. In discussing protection against coordinated air-, surface-, and submarine-launched antiship missiles, it is useful to divide the process into two steps: destroying the weapon launcher before it can fire, and destroying the missile after it has been launched.

Detecting aircraft is much easier than detecting submarines. Yet the speed of aircraft is so high and the standoff range of their air-launched weapons so great that the battle for air superiority at sea is greatly compressed in time. There is therefore a premium on readiness and the ability to engage several enemy aircraft or missiles at once.

The problems of detecting and destroying submarines before they can launch their missiles have already been discussed. Defense against the SSN-7 submerged-launch antiship missile is severely limited; its short range (30 nm) and high speed (M 1.5) leave little time for the defense to react. Here again, therefore, there is a premium on readiness and quick response by the defense.

The problems posed by antiship missiles launched from surface ships are different. If the opposing surface forces are intermixed, the one that strikes first gains an advantage; it is sure to launch most of its antiship missiles. If the attack is a surprise, the advantage is even greater; retaliation may be delayed -- or even avoided entirely. The vulnerability of surface ships to antiship missiles, therefore, makes for an unstable situation when two surface forces are in the same area at a time of high tension.

If the opposing forces are separated, however, surveillance systems may be so important that each side will find it necessary to destroy the other's surveillance systems. If they are, in fact, destroyed, the pace of naval warfare will turn out to be far slower than is now envisioned. The result can be likened to a night baseball game with many of the lights turned out and others dimmed. Pitchers would have trouble reading signals from the catchers. Batters would not get signals from the third base coach. There would be many errors and passed balls, and innings would last a long time.

Regardless of the fate of surveillance satellites, protection of the U.S. fleet from attack by large surface ships is not likely to be a serious problem. The Kievs, Krestas, and Karas would be the first of the Soviets' major forces to sustain heavy losses.

Defense Against Air Attack in the 1980s. In the 1980s, the U.S. carrier forces will still be able to destroy the Soviet surface fleet. This capability will be strengthened by the wide deployment of Harpoon antiship missiles and the longer-ranged Tomahawk missiles. Problems in long-range targeting will be largely overcome by a variety of onboard and offboard surveillance and targeting systems.

However, the Soviet surface fleet can be expected to launch many of its missiles at U.S. forces on D-day. Protection against these missiles will require improved antimissile systems and soft-kill systems. After D-day, the Soviet surface forces will add little to the threat to the U.S. fleet.

The main elements of the U.S. fleet's protection against Soviet aircraft in the 1980s -- land-based early warning systems, land-based interceptors, the large-deck carrier, and the F-14/Phoenix system -- are already in place. NATO surveillance and early warning systems will be in position to detect Soviet aircraft long before they can reach the operating areas of the U.S. fleet. Though Soviet air attacks may be flown by circuitous routes or at low altitudes, either option will reduce their attack radius. In many areas, land-based interceptors will be able to engage Soviet attackers long before they can arrive at their launch points. In these engagements, some of the attackers will be killed and, fully as important, the coordination of the Soviet attack will be broken up.

Soviet bombers that survive this combat with land-based interceptors and reach the fleet operating areas will be engaged by carrier-based forces. The E-2C aircraft will provide early warning and aerial combat coordination. The F-14A, now widely deployed, has a substantial capability for intercepting the Soviet navy's strike aircraft. Cumulative attrition by land-based interceptors and carrier-based F-14s will greatly reduce the number of antiship missiles actually launched at U.S. surface ships.

By the late 1980s, the ability of the fleet to detect, intercept, and either destroy or evade antiship missiles will be greatly enhanced by newly introduced systems. The most prominent of these is Aegis, which will have a fixed, phased-array radar, resistant to enemy countermeasures, and will be managed or directed by modern computers. Aegis will incorporate a rapid-fire launching system for the new SM-2 missile. Introduction of the Aegis system will increase substantially the fleet's ability to defeat enemy missiles. The net effect will be to make saturation of the fleet's air defenses far more difficult. In the 1980s, though, deployment of this large, expensive system will be limited to the few large surface combatants that operate with carrier task groups.

A new point defense or close-in weapons system (CIWS), Phalanx, is being developed, for last-ditch defense against antiship missiles. This is a 20 mm gatling gun that has its own search and track radars and fire control system. The system is small enough to be mounted on a wide variety of U.S. Navy ships.

Electronic warfare (EW) systems will also be important in protection of the fleet in the 1980s. Their purpose will be to provide electromagnetic warning and surveillance. EW systems will, in addition, incorporate active countermeasures to deny targeting information and to decoy enemy weapons away from their targets. As with "hard-kill" defenses, EW will make extensive use of computers to correlate detections, identify threats, and pick the right responses.

Defense Against Air Attack in the 1990s. Improvements in fleet protection against air and missile attacks will continue through the 1990s. U.S. antiship missiles should be more sophisticated, better able to locate Soviet ships and penetrate their defenses. Improvements in surveillance systems will make employment easier. Consequently, the threat from Soviet surface ships should remain the least serious part of the problem of protecting the fleet.

Incorporation of the Aegis system into the fleet is likely to continue into the 1990s. Undoubtedly, parts of the system will be modified and improved to keep pace with developments in Soviet missile and electronic warfare technology.

A new system -- Shipboard Intermediate Range Combat System (SIRCS) -- is planned to arrive in the late 1980s; it will be available in sizable numbers in the 1990s. SIRCS is intended to provide intermediate-range surface-to-surface and self-defense capabilities to naval surface combatants not equipped with Aegis. In its present concept, the system is designed for fast reaction,sizable area coverage, and potent firepower. When deployed, SIRCS will greatly enhance the self-protection of naval combatants.

Scientists are also studying the use of high-energy lasers in naval warfare.[22] This work involves research into phenomenology and development of individual components of a laser system, such as a pointer/tracker and automatic aimpoint selection. Though this program is directed at use of high-energy lasers for protection against missiles, it is far too soon to tell what roles they may play in the fleet of the 1990s.

The high speed of aircraft means that there is a premium on detecting them early and tracking them closely. The Air Force reportedly has at least two programs underway for detecting and tracking aircraft from space. One -- called Teal Ruby -- would employ infrared detectors for spotting aircraft. The second, called HALO, would employ optical means. Either system might provide early warning of air attacks directed toward the fleet from Soviet naval airfields.[23]

Aircraft will continue to play an important role in defense against aircraft in the 1990s. Investigations of roles for large land-based aircraft in naval warfare include consideration of ways in which these aircraft can strengthen the fleet's air defenses. One possible role is airborne early warning; the possibility of arming the plane with air-to-air missiles must also be considered.

The VSTOL program is a more likely candidate for enhancing the role of aircraft in protecting the fleet in the 1990s. The Navy's program for VSTOL includes development of a VSTOL fighter by the mid-1990s. Such a capability would raise a number of possibilities for combatting attacks on the fleet in the 1990s.

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[22] See, for example, D.M. Cordroy, et al., Meteorological Sensitivity Study on High Energy Laser Propagation, Naval Research Laboratory Report 8077, January 1975.

[23] See Barry Miller, "Aircraft Detection System Advances," Aviation Week and Space Technology, June 20, 1977, pp. 22-23.

Future Developments

There is no evidence to suggest either that the day of the surface fleet has passed or that the problems of protecting the fleet will be easily solved. The problems of defending the fleet requires consideration of these important possibilities:

1. The fleet can be so disposed as to minimize the risk and damage of surprise attack. Dispersing the fleet's striking power and concealing its operations -- as much as possible -- are types of actions that can improve the readiness of forces by operational and tactical changes that are relatively inexpensive.
2. The Navy can maintain its superiority in submarine design by investing the resources and employing submarines in a variety of antisubmarine roles.
3. Naval warfare will rely more than ever before on intelligence. The Navy's planning can provide for denying the enemy vital information about the fleet and its weapons, sensors, and operations.
4. Protection of the fleet will require coordinated action by land- and sea-based systems, including some outside the Navy's control. To maintain coordination in the face of enemy counter-measures will require responsive systems of command and control.
5. Surveillance systems may prove to be so important that each side will try to destroy the other's. If these systems are, in fact, destroyed, the pace of naval warfare will turn out to be far slower than is now envisioned. The Navy should plan for this possibility.

6. To enhance the effectiveness of the Navy's own ASW and to provide it with information about possible countermeasures, the Navy can conduct more research in non-acoustic techniques for detecting submarines.

PROTECTING THE FLEET AGAINST SMALLER NAVIES

General purpose forces of the Navy and Marine Corps have served as instruments of national policy in a wide variety of situations. According to a Brookings Institution report, naval units participated in more than 80 percent of 215 incidents in which the U.S. leadership used armed forces between 1945 and 1975.[24] In some of these cases, armed opposition was possible; in a few instances, it took place.

In the future, military opposition may be much more effective, as a consequence of the diffusion of modern naval technology. In addition, increases in national claims to the sea and its resources add to the possibility of naval warfare.

The consequences of the new technologies for naval warfare have received little discussion, though some of these "new" technologies have been in naval use since 1958. Since Soviet-made Styx missiles sank the Eilat in 1967, perhaps 100 to 150 antiship missiles have been fired in anger, sinking another destroyer, 10-15 smaller naval craft, and about 5 neutral merchant ships.

There is a growing belief that new types of weapon systems will make smaller navies much more capable, for example, of causing temporary embarrassment to superpower navies. The new technologies mentioned most often are: precision-guided weapons, remotely-piloted vehicles, VSTOL aircraft, surveillance and targeting systems, and electronic measures and countermeasures. One main theme is that the new technology favors

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[24] Barry M. Blechman and Stephen Kaplan, "Armed Forces as a Political Instrument," Survival, Vol. XIX, No. 4 (July-August 1977), p. 170.

defense forces. Large, visible attacking units, such as carriers and cruisers, are thought to be more easily detectable by the new sensors and more vulnerable to attack with the new weapons. For smaller navies, however, such potentialities lie largely in the future.

At present, the navies of most small nations have only local defense functions and largely outdated equipment for performing them. Some of these countries are modernizing their forces, more with an eye on each other than any plan to counter the forces of larger naval powers, such as the U.S., the Soviet Union, the United Kingdom, or France. Modern weapon systems in the hands of a small navy may help deter attack by neighbors, and some could undoubtedly win local naval conflicts. None, however, is equipped to deny local seas to a superpower or to project naval power at a distance.

Could a smaller navy -- with frigates and patrol craft mounting antiship missiles, with new diesel submarines, with land-based air, with precision-guided munitions, etc. -- stop the U.S. Navy from projecting forces into an area? Probably not.

There are two main reasons. One is relative economic strength. A small navy with new technology might inflict an initial shock if it struck first at the U.S. fleet. We would be less likely to engage in gunboat diplomacy against any nation with such a navy. But a U.S. Navy that is sized to fight the Soviet fleet could, obviously, soon muster the forces to obliterate even the best of the smaller navies.

More important: The U.S. and Soviet navies have great incentives for staying ahead in the technology of naval warfare; they will probably stay well ahead of other arms producers. Moreover, neither navy is likely to release its best and latest technologies to any but its firmest allies -- and perhaps not even to them. In conflicts with smaller navies, therefore, the U.S. fleet is likely to encounter older or less capable systems and in relatively small numbers.

Predicting the possible evolution of specific small navies is difficult. The future of these forces depends on domestic stability, regional problems, economic development, international alliances, and so on. But it is possible to see what $100-150 million a year spent on naval forces might buy for a typical or nominal smaller navy.

TABLE 4

NOMINAL "SMALL" NAVY OF THE FUTURE
(Millions of 1977 dollars)

	Number	Procurement cost	Annual operations	Twenty-year systems cost
Diesel submarines	3	$37.0	$3.5	$321
Missile frigates	2	84.5	5.0	469
Frigates	2	70.0	4.0	300
Corvettes	5	40.0	3.0	500
Fast patrol boats	10	12.0	0.7	260
P-3 aircraft	10	18.0	0.8	340
ASW helicopters	10	3.0	0.3	90
Subtotal: Force investment and operational costs				$2,180
Command, training, and administration (1/3 of operating costs)				115
Total cost				$2,295
Average annual cost				$ 115

Such a force would contain 150 antiship missile launchers at most and would lack adequate capabilities for distant surveillance and targeting.[25] Experience suggests that smaller nations have even more problems, including maintenance, training, and reliability. Even this nominal modern navy, therefore, would probably be unable to muster more than half of its forces for an attack. In all likelihood, such a navy would lack the real-time command and control capability to launch a well-coordinated air, surface, and submarine attack. The U.S. fleet, accordingly, would face a poorly coordinated attack by small numbers of older missiles.

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[25] Information about the movements of the U.S. fleet could, of course, be furnished by the Soviets.

Under such circumstances, such a force might still take on a U.S. carrier task group. In the 1990s, the U.S. group would probably include a single large-deck carrier or several smaller carriers with VSTOL aircraft. In either case, it would have 75 to 100 tactical aircraft, all of them at least as capable as today's F-14s, S-3s, A-6s, and E-2Cs. There would probably be two Aegis/SM-2 ships in the force and about six other surface combatants. All would have the Phalanx CIWS and up-to-date electronic warfare systems. Submarines would accompany them. The force would also have substantial numbers of Harpoon or Tomahawk launchers. Finally, the commander on the scene would be supported by remote systems for ocean surveillance and computerized systems for command and control.

Unless the small navy achieved complete tactical surprise, its strongest attack could probably inflict only slight damage on the U.S. force. The U.S. force's surveillance, coastal aircraft, and Tomahawk missiles would enable it to stand off and attack the enemy's small surface force from a distance. Its airborne early warning aircraft and fighter aircraft should be able to blunt the enemy's air attack and turn it. And the Aegis systems could easily handle any enemy missiles that survived to be launched at the task group.

Admiral Holloway estimated that the U.S. fleet might lose 10 percent of its carriers, i.e., one to two carriers, in combat with a Soviet client. The analysis just presented suggests that this is an overestimate. At worst, combat with the nominal small navy might result in one or two hits on a U.S. carrier.

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